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TEST AND EVALUATION OF CONTAINER MK 618 MOD 0 FOR HARPOON ROCKE--ETC(U)

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TEST AND EVALUATION OF CONTAINER MK 618 MOD Ø FOR HARPOON ROCKET MOTOR SECTION P/N72/P250001-1103 USED FOR BOOSTERS A/B44G-2 AND A/B44G-3.

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This report details the test and evaluation of a prototype container MK 618 MOD 0 designed to protect a HARPOON Rocket Motor Section P/N 72P250001-1103 for fleet use. Test results indicated that the container is suitable for its intended purpose.

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TEST AND EVALUATION

OF

CONTAINER MK 618 MOD 0

FOR

HARPOON ROCKET MOTOR SECTION P/N72P250001-1103

USED FOR BOOSTERS A/B44G-2 AND A/B44G-3

Abstract

This report details the test and evaluation of a prototype Container MK 618 MOD 0 designed to protect a HARPOON Rocket Motor Section P/N72P25001-1103 for fleet use. Test results indicated that the container is suitable for its intended purpose.

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INTRODUCTION

The Naval Weapons Handling Center, WPNSTA Earle was tasked to design, develop and document a shipping and storage container for the HARPOON Rocket Motor Section P/N72P250001-1103. As a result of this task a prototype container designed by NWHC, WPNSTA Earle and fabricated by Container Research Corp. was tested in accordance with applicable requirements of MIL-STD-648.

The primary objectives of the tests were to evaluate the adequacy of the container in providing shipping, storage, and handling protection for a packaged HARPOON Rocket Motor Section. The following sections of this report present the details of the test program.

ITEM DESCRIPTION

The test Container MK 618 MOD 0 is designed and fabricated in accordance with DL 2645305, to meet the requirements of specification XAS-4314A. It is a steel chest-type container mounted to a rectangular tubular base, Figure 1. The container handling provisions consist of side lift fork pockets, four hoisting fittings and a flange on each end to enable the top of the container to be manually lifted. Shock mitigation is accomplished by cushion assemblies as shown in Figure 2. The cushioning consists of 6 pounds per cubic foot nominal density polyethylene foam assemblies bonded to the top and base sections of the container and offering the rocket motor shock mitigation in the vertical and transverse direction. The two (forward and aft) end cap cushions (2 pounds per cubic foot nominal density polyethylene foam) bonded to plywood platens offer the rocket motor shock mitigation in the longitudinal direction. The

rocket motor is shown assembled in the container, Figure 3. The external overall dimensions of the container are 52" long x 23-7/8" wide x 25-7/8" high. The empty weight of the container (with cushion assemblies) is 277 pounds and the loaded weight (with the rocket motor) is 535 pounds. The rocket motor section tested, P/N72P250001-1103, is used in the subsequent assembly of Rocket Motor Section Booster A/B44G-2 or A/B44G-3.

TEST EQUIPMENT AND INSTRUMENTATION

The rocket motor was instrumented with two triaxial accelerometers located at its forward and aft ends and unidirectional accelerometer located at the c.g. Rocket motor response was recorded on magnetic tape at a speed of 30 inches per second for shock tests and 15 inches per second for vibration. The response signals were played back at 1-7/8 inches per second into a hot pen recorder to obtain visual records. An instrumentation list is included as Table I.

Major test equipment used to provide dynamic inputs and environmental conditioning are listed below:

1. LAB 8000 SLVMO-10 Transportation vibration simulator used for Low Order Repetitive Shock.

2. LING Vibration Exciter System XPXO/16 with an A300 Shaker - Used for vibration sweeps in the frequency range 5 - 500 Hz.

3. CONRAD WD 1024 Walk In Temperature and Humidity Chamber - Used to thermally condition the test item for shock tests.

A digital computer program (SPECT) was used to generate shock response spectrum comparisons between the test data and allowable shock.

TEST PROCEDURES AND RESULTS

Tests were conducted in accordance with specification XAS-4314A and acceptance tests outlined in MIL-STD-648 and FED-STD-101B. Unless otherwise noted, test procedures and results are presented in the sequence conducted.

1. Inspection and Fit Test. The container was visually and dimensionally inspected for conformance to the drawing package DL 2645305. In addition, the form, fit and function tests of specification XAS-4314A, paragraph 4.2.2.1 were conducted. Observations were made for ease of loading and if any interference existed between the rocket motor section and cradle assemlby and/or any restrictions inhibiting the closure of the container.

Results - The container was within the dimensional tolerances specified. Fit and compatibility of the rocket motor section and placement of the container top section were performed without difficulty. However, some difficulty was experienced with the two T-bolt fasteners located at each end of the container. Although locking of the fasteners was accomplished using an open end wrench, their location (in line with the vertical rectangular tubular members) does not allow sufficient clearance to use a socket wrench which would expedite closure.

2. Leakage Test (Initial). This test was conducted at room temperature (70°F) using the pneumatic pressure technique outlined in

Method 5009 of FED-STD-101 and the pressure requirements outlined in MIL-STD-648, paragraph 5.6, Table II.

In preparation for the leak test, a fitting was installed through the container humidity indicator hole. The fitting is designed to allow an external source of compressed air to be piped into the container, which can be monitored by means of an air pressure gage. When the air pressure gage recorded the nominal specified container pressure, the external air supply was shut off. Air pressure corrections were made to compensate for the effect of temperature change of the throttled air before monitoring the leak rate. The container air pressure test requirements are 2.5 $\pm$ .5 psig, with a pressure drop not exceeding 0.05 psig during an elapsed time of one hour after pressurizing the container.

Results - No leakage could be detected during the one hour test period.

NOTE: This test was repeated after completion of all tests as described in this report. The result was the same.

3. Repetitive Shock Test. This test was conducted at an ambient temperature of approximately 70°F in accordance with paragraph 5.2.2 of MIL-STD-648 and Method 5019 of FED-STD-101B.

The loaded container was placed base down on a vibration table (LAB-8000 SLVMO-10) having a vertical linear motion of 1" double amplitude. The frequency of the table motion was increased until the container left the table by 1/16" at some instant during each cycle. The container was

vibrated for two hours under these conditions with an input frequency of 3.8 Hz.

Results - Post test examination disclosed no visible damage to either the rocket motor section or container.

4. Vibration Fatigue Test. This test was conducted at 70°F in each of the three mutual perpendicular axes. To determine the natural frequency and peak transmissibility a sinusoidal sweep was conducted through the specified frequency range of 5 to 500 Hz. The test item was then vibrated for 30 minutes (uninterrupted) along each of the three axes at the resonant frequency determined from the sweep.

Results - Figures 4 - 9 show the transmissibility characteristics both before and after the 30 minute dwell test superimposed upon the allowable transmissibility. They clearly indicate that with the exception of 66 - 68 Hz resonance peaks in the vertical data (Figures 8 and 9), the transmissibility in all three axes are within the allowable level. Investigation of resonance peaks at 66 -68 Hz in the vertical vibration sweeps revealed that they are test fixture induced. The control accelerometer was relocated to eliminate the effect of fixture flexture and the sweep repeated. The result of this sweep presented as Figure 10 shows that the vertical transmissibility characteristics are within the allowable level. A difference in the frequency and amplitude of resonance are readily discernable between Figure 10 and Figures

8 and 9. The sweep of Figure 10 was performed at a double amplitude of 0.125 inch while those of Figures 8 and 9 were performed at 0.03 inch double amplitude (due to equipment problems which were subsequently corrected). The greater amplitude excitation results in a lower resonance frequency because of the non-linear characteristics of the foam and lower transmissibility because of more effective damping. Lower transmissibility is also attributed to the elimination of fixture motion from rocket motor response accomplished by the relocation of the control accelerometer.

Although resonances in the 50-80 Hz range in the transverse and longitudinal axes are within the allowable level it is believed that they are also the result of fixture resonance as reflected by the original location of the control accelerometer.

A summary of the sweep results are tabulated below:

	Excitation at Res.	Before Dwell		After Dwell	
Axis	(inch D.A.)	Fn	Tran.	Fn	Tran.
Vert.	.03/.125*	16	5.7	12.5	2.4
Trans.	.125	12	4.5	10	5.9
Long.	.04	8	3.6	7.4	3.8

*0.030 inch DA before dwell

0.125 inch after dwell

A post test examination of the container and contents indicated that there were no detrimental effects of the dwell tests.

5. Shock Tests

a. Rotational Corner-Drop Tests. This test was conducted in accordance with paragraph 5.2.4 of MIL-STD-648 and Method 5005 of FED-STD-101B by supporting the loaded container at one end by a 6 inch block at one corner and a 12 inch block at the adjacent corner. The corner diagonally opposite the 12 inch block was raised to a height of 36 inches and allowed to free fall and impact on a concrete surface. This test was conducted with the container conditioned at 140°F and -20°F. A total of four (4) drops were conducted (two at each temperature).

b. Incline-Impact Test. This test was conducted in accordance with paragraph 5.2.7 of MIL-STD-648 and Method 5023 of FED-STD-101B with optional timber. The loaded container was placed on the carriage of the tester and released from a predetermined point on the ten-degree track that had been calibrated to obtain an impact velocity of 10 and 7 ft/sec. This test was performed on both ends at 10 ft/sec and on both sides at 7 ft/sec. This sequence of incline impact tests were conducted with the container conditioned at 140°F and -20°F for a total of eight (8) impacts.

c. Drop Test (Free-Fall). This test was conducted in accordance with paragraph 4.2.2.10.2 of specification XAS 4314A and paragraph 5.2.1.1 of MIL-STD-648 at room temperature. The loaded container was raised

to a height of 18 inches and allowed to free-fall flat on its base on an unyielding surface (concrete).

Results - A summary of the shock results is presented in Table II and the major deceleration-time curves are shown in Figure II. The shock response spectrum of the largest shock was generated and compared to the allowable spectrum. This comparison presented as Figure 12 clearly shows that the spectrum of the response pulse is within the allowable spectrum. Shock spectra for other shocks were not computed because of their significantly lower amplitudes.

6. Forktruck Handling Test. The "lifting and transporting by forktruck" test outlined in paragraph 6.2 in Method 5011 of FED-STD-101B was performed using a standard 4000 pound capacity electric powered forktruck. The loaded container was hoisted by the forktruck and driven 100 feet over 1-inch high boards spaced 54 inches apart at right angles, 60°, and 70° from the path of travel.

Results - The container was handled by the forktruck with no noticeable difficulty or structural degradation.

7. Skid Strength Test. The pushing and towing test of Method 5011, paragraphs 6.5 and 6.6 of FED-STD-101B, was performed using a standard 4000 pound capacity electric powered forklift truck. The pushing test was performed with the forks of the vehicle extended through the container forklift pockets, but not supporting the container, the vehicle mast was positioned vertically. The container was pushed along a concrete surface a distance of 35 feet in approximately 85 seconds. The towing test was

performed by placing an appropriate tow line about the container and attaching the opposite end of the tow line to the forklift truck. The container was towed along a concrete surface a distance of 100 feet in approximately 23 seconds. This test was performed twice. Once with the container's longitudinal axis parallel to and once at a right angle to the vehicle path of travel.

Results - Aside from scrape marks, there was no damage inflicted to the container body or skid surface.

8. Concentrated Load Test. The concentrated load test was performed as specified by paragraph 4.2.2.6 of XAS 4314A. The container was subjected to a load equivalent to that imposed by stacking four loaded containers upon the bottom container. The load was based on the gross weight of one container (535 pounds) and consisted of 2,140 pounds. The overload was maintained for a 12 hour period.

Results - A visual inspection of the container showed on evidence of damage.

9. Hoisting Strength (Four Point Overload). Conducted in accordance with paragraph 4.2.2.9 on XAS 4314A. The container's four hoisting fittings were overloaded 5:1 based on the gross weight on one loaded container, 535 pounds. The loaded container was positioned under a hydraulic tension machine and hoisted with an appropriate sling attached to the four hoisting fittings. The container was secured to the deck and a tension load of 2,675 pounds was applied to the hoisting fittings. The test was maintained for a 5 minute period.

Results - On completion of the test, there was no visible indication of structural degradation of the lifting fittings. However, it was noted that insufficient clearance exists between the liftirg fittings and the container body resulting in binding of the sling hooks.

10. Hoisting Strength (Single Point Overload). This test was performed by hoisting the loaded container by a single hoisting fitting. This test was performed on all four fittings and in each case was held for a 5 minute period.

Results - On completion of this test, visual inspection showed no evidence of structural failure of the lifting fittings.

CONCLUSIONS

The results of this evaluation indicate that the Container, MK 618 MOD 0, meets the required criteria and is suitable for its intended purpose as a shipping and storage container for the HARPOON Rocket Motor Section P/N72P250001-1103. Test results indicate the cushion system employed in the container provides adequate isolation from the shock and vibration inputs specified. The condition of the container after completion of all tests was good and was considered structurally capable of being reusable. Two problem areas exist and are listed below.

1. The T-bolt fasteners located at the foward and aft ends are partially inaccessible resulting in some difficulty in locking/unlocking operations.

2. The location of the four lifting fittings do not allow sufficient clearance to permit the hoisting sling hooks to assume a normal, in line configuration with the sling legs during hoisting.

RECOMMENDATIONS

Based upon the conclusions it is recommended that the T-bolts located at the container ends and the hoisting fittings be relocated to permit appropriate clearances. (It should be noted that these recommendations have been implemented by modifying the drawing package to reflect relocation of the T-bolt fasteners inboard of their present location and the lifting fittings downward. Both of these modifications should be effective.)

TABLE I

SHOCK AND VIBRATION INSTRUMENTATION

ITEM	MANUFACTURER	MODEL	SERIAL NO.
Accelerometer (2)	Endevco	2223C	LA80/LA440
Accelerometer (1)	Endevco	2221D	JB80
Accelerometer (2)	Endevco	2219	FB16/FB17
Vibration Pickup (1)	MB	126	16419R
Signal Conditioner (7)	Endevco	4470	
Charge Amplifier (7)	Endevco	4477	
Charge Amplifier (2)	Endevco	2720P	
Vibration Meter (1)	MB	M-6	
X-Y Plotter (1)	Moseley	135A	
Impedance Analyzer (1)	Spectral Dynamics	SD-1002A	
Magnetic Tape Recorder (1)	Sangamo	4700	
Pen Reloader (1)	Beckman	RS	

TABLE II

Peak Deceleration (g's) and Time Base (ms) at Accelerometer Nearest to Drop Corner

Test Event	Longitudinal Axis				Transverse Axis				Vertical Axis			
Cornerwise-Drop (Rotational)	-20°F		140°F		-20°F		140°F		-20°F		140°F	
36" Height	g's	ms	g's	ms	g's	ms	g's	ms	g's	ms	g's	ms
FWD-STBD	10.5	45			14.8	25			18.1	25		
AFT-PORT	8.1	33			12.9	17			*	*		
FWD-PORT			7.2	62			4.5	35			10.3	65
AFT-STBD			5.9	67			9.2	47			10.2	65
Impact Test												
10 ft/sec FWD END	10.3	28	8.1	77								
10 ft/sec AFT END	11.1	45	7.4	87								
7 ft/sec STDB SIDE					13.2	28	7.5	60				
7 ft/sec PORT SIDE					13.2	28	7.8	62				
18" VERTICAL SHOCK									70°F			
Bottom Face									14.2 g's	47 ms		

*Instrumentation Failure

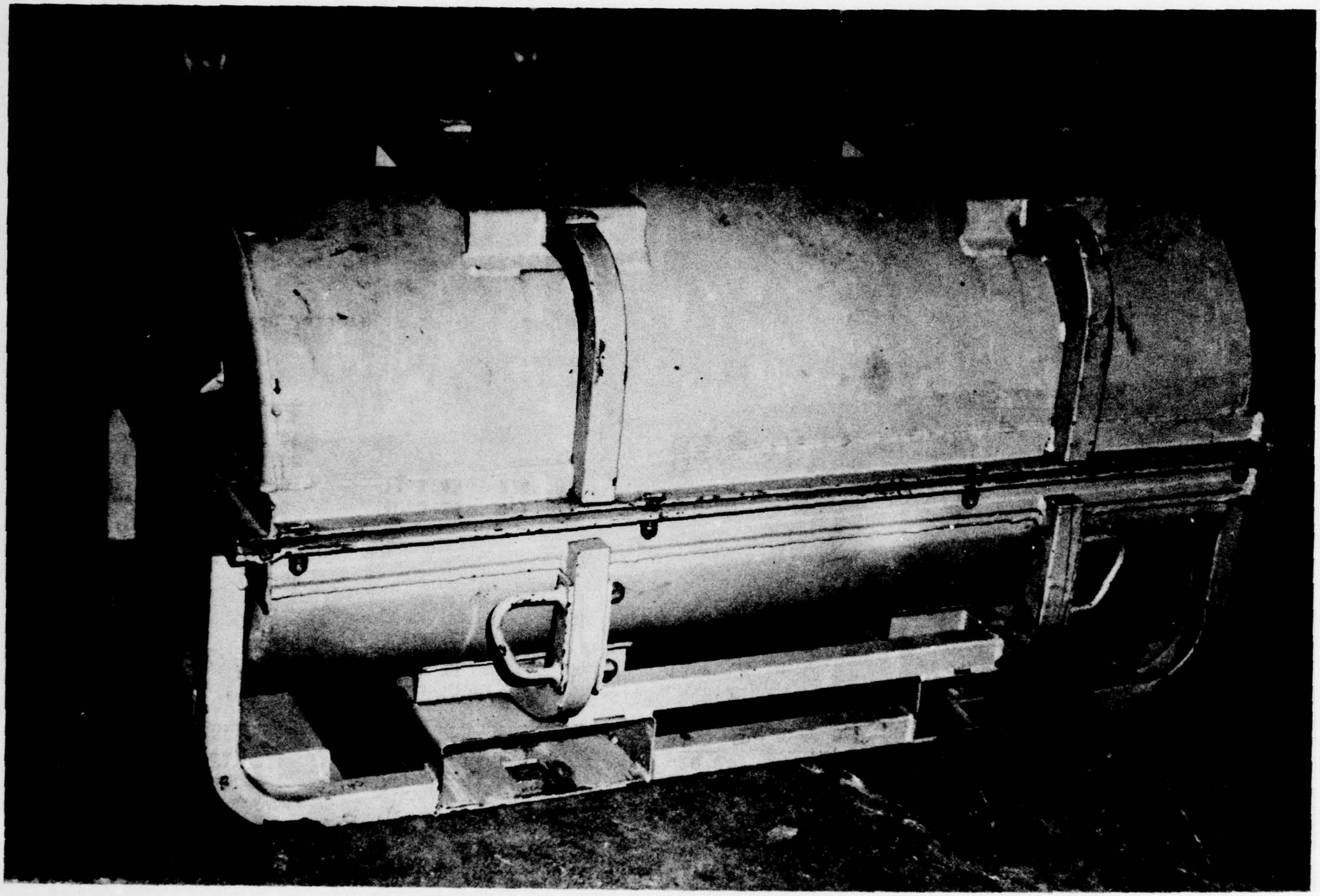


FIG. 1 CONTAINER MK 618 MOD 0

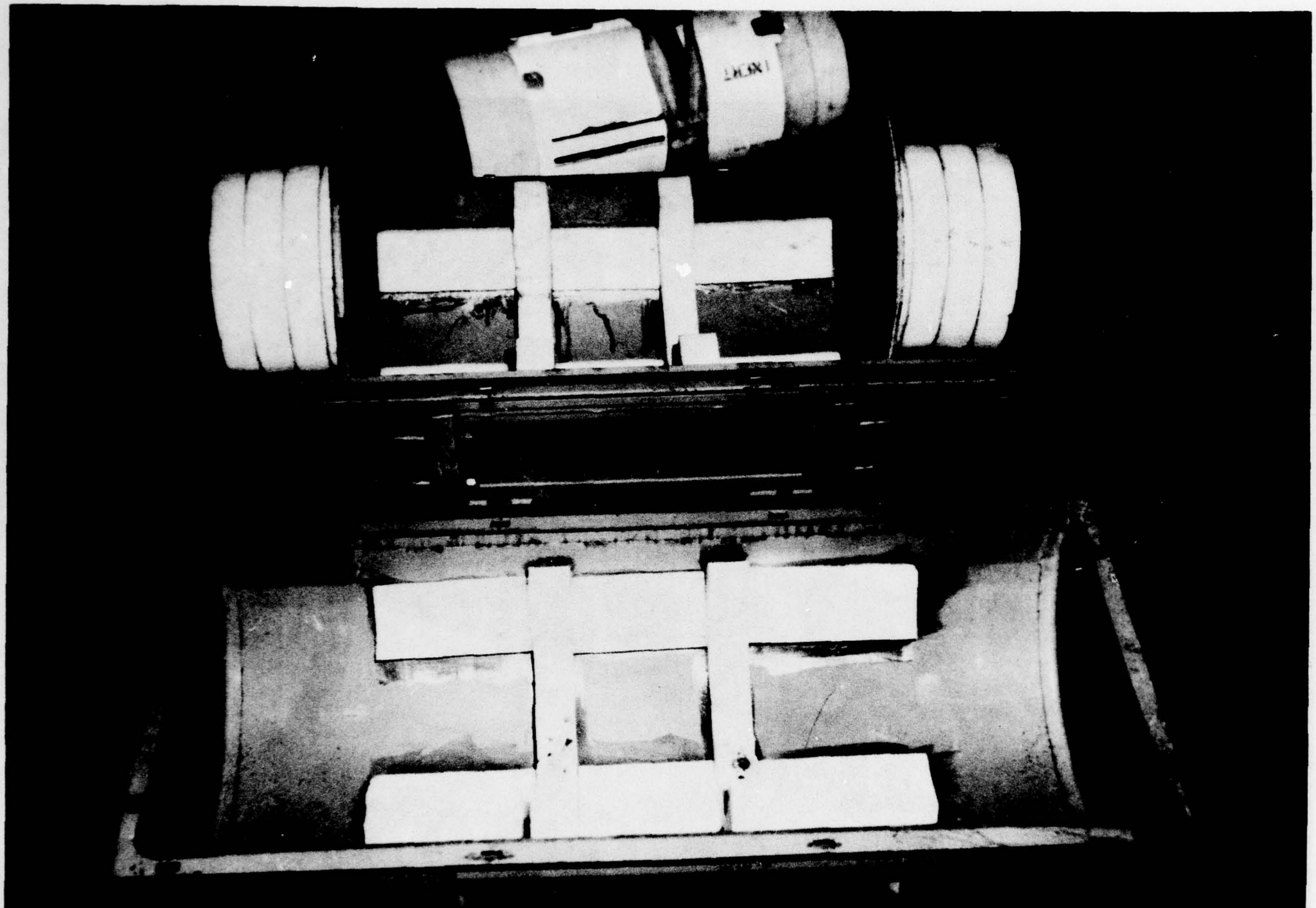


FIG. 2 CUSHIONING SYSTEM.

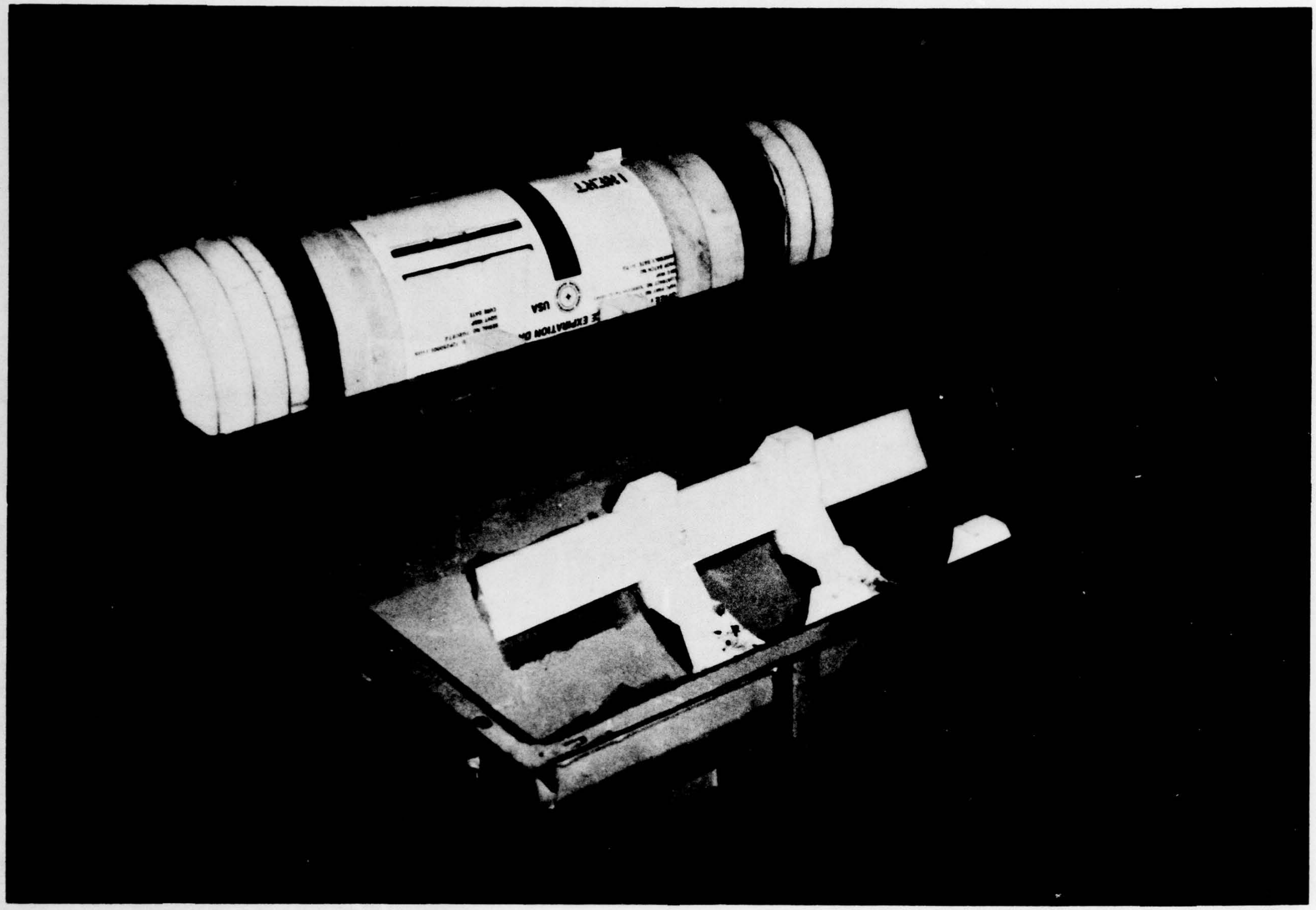


FIG. 3 PACKAGED ROCKET MOTOR.

FIGURE 4 TRANSVERSE - RESONANCE SEARCH

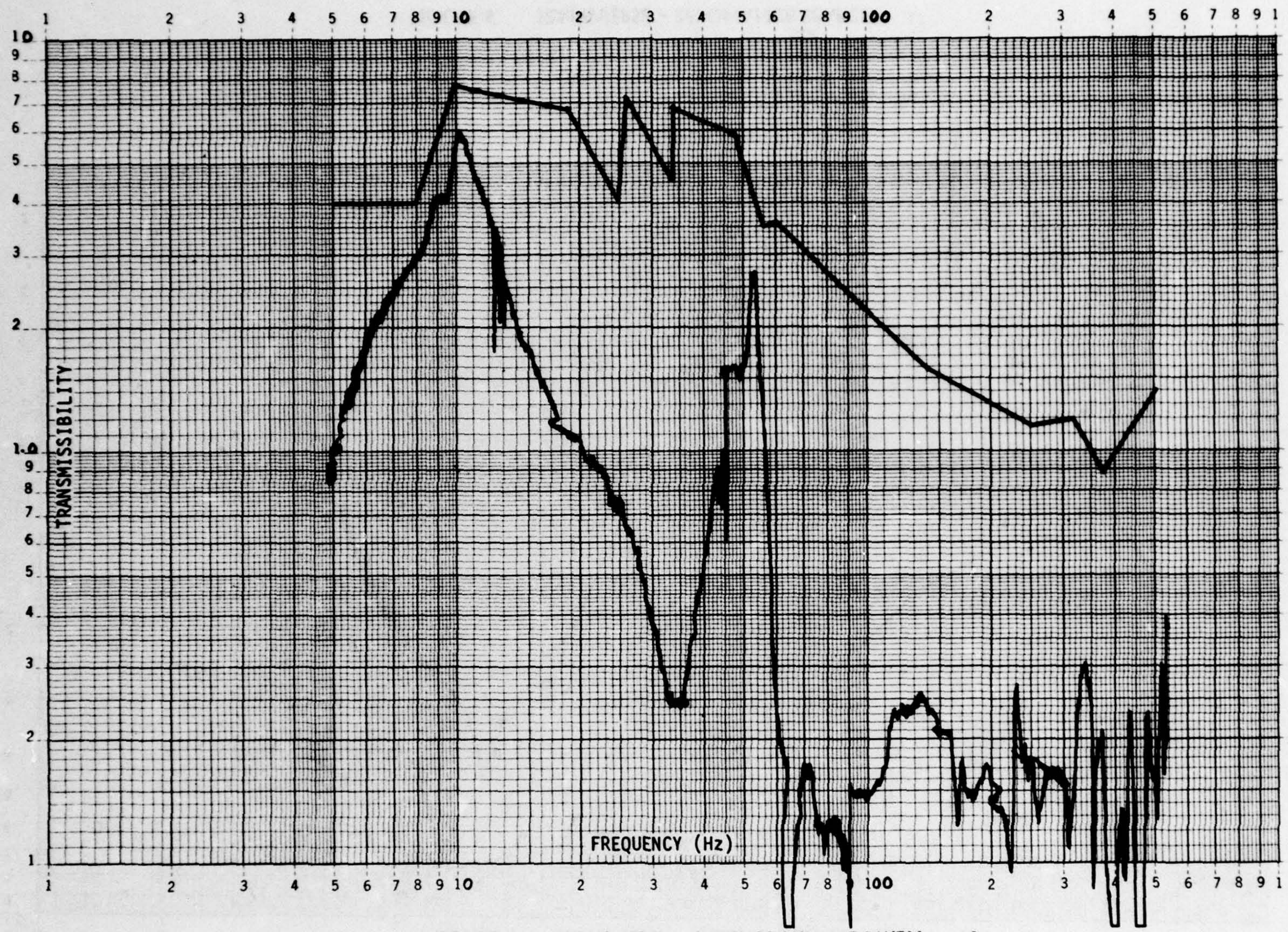


FIGURE 5 TRANSVERSE - AFTER 30 MINUTE DWELL

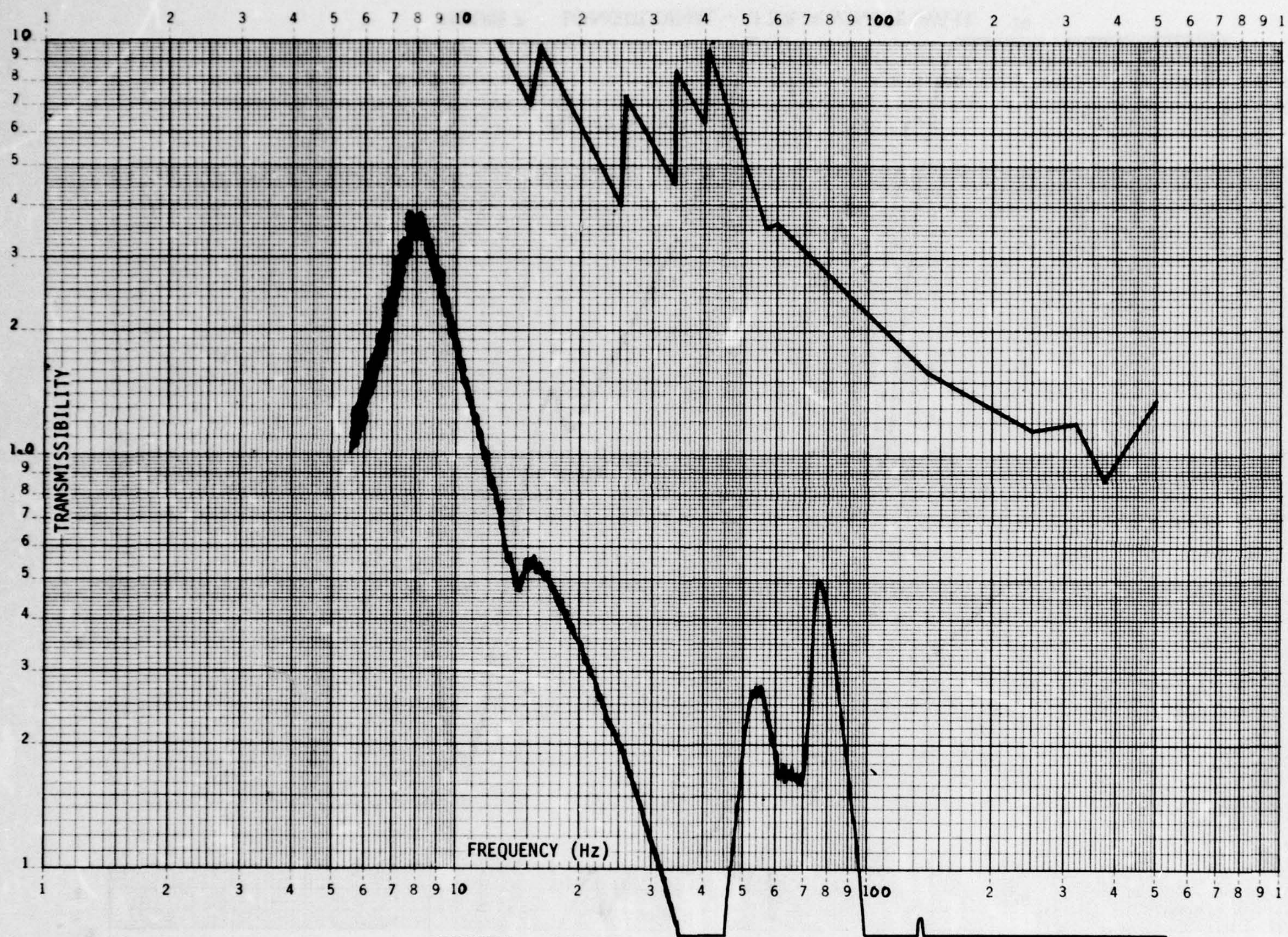


FIGURE 6 LONGITUDINAL - RESONANCE SEARCH

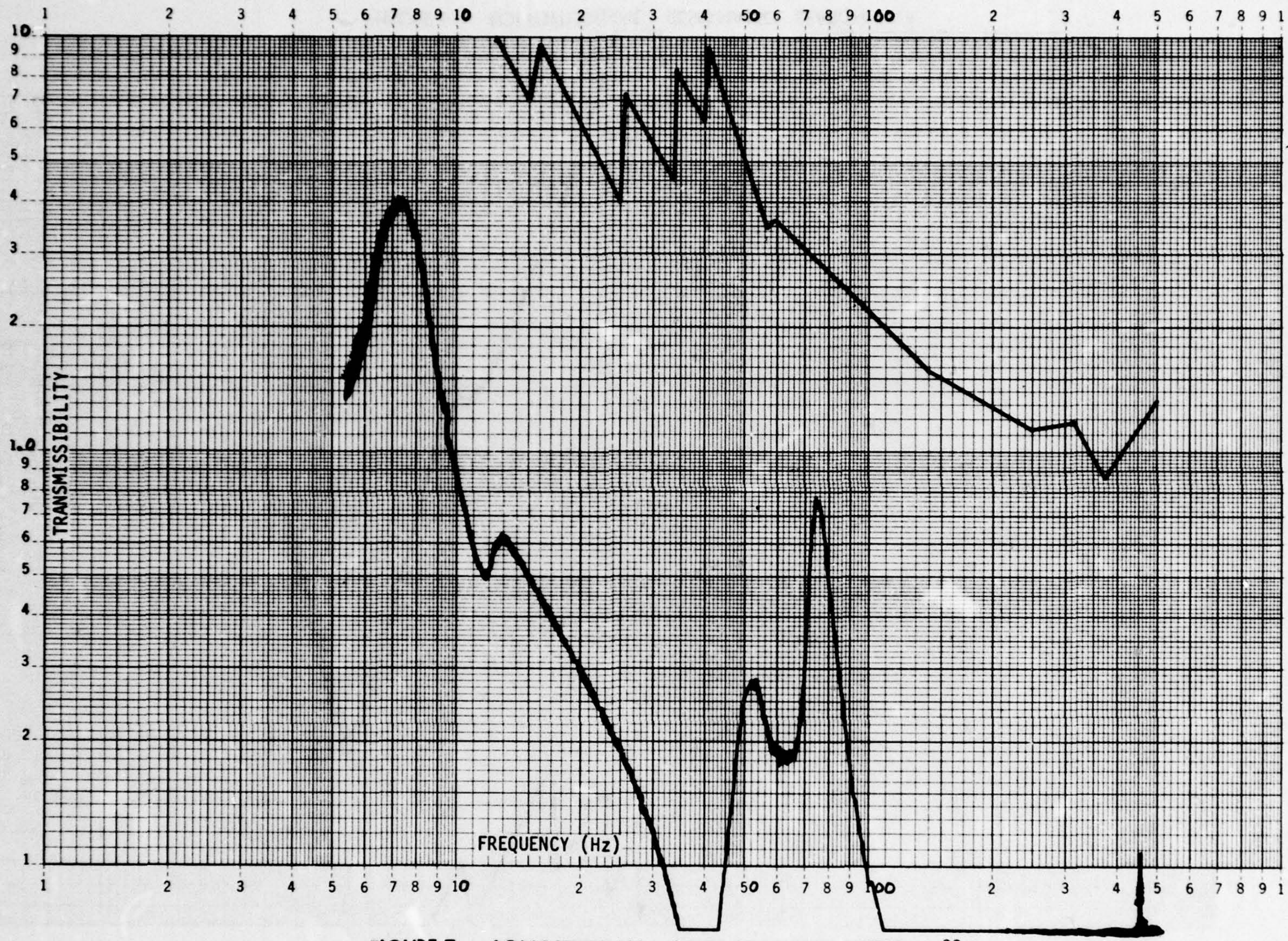


FIGURE 7 LONGITUDINAL - AFTER 30 MINUTE DWELL

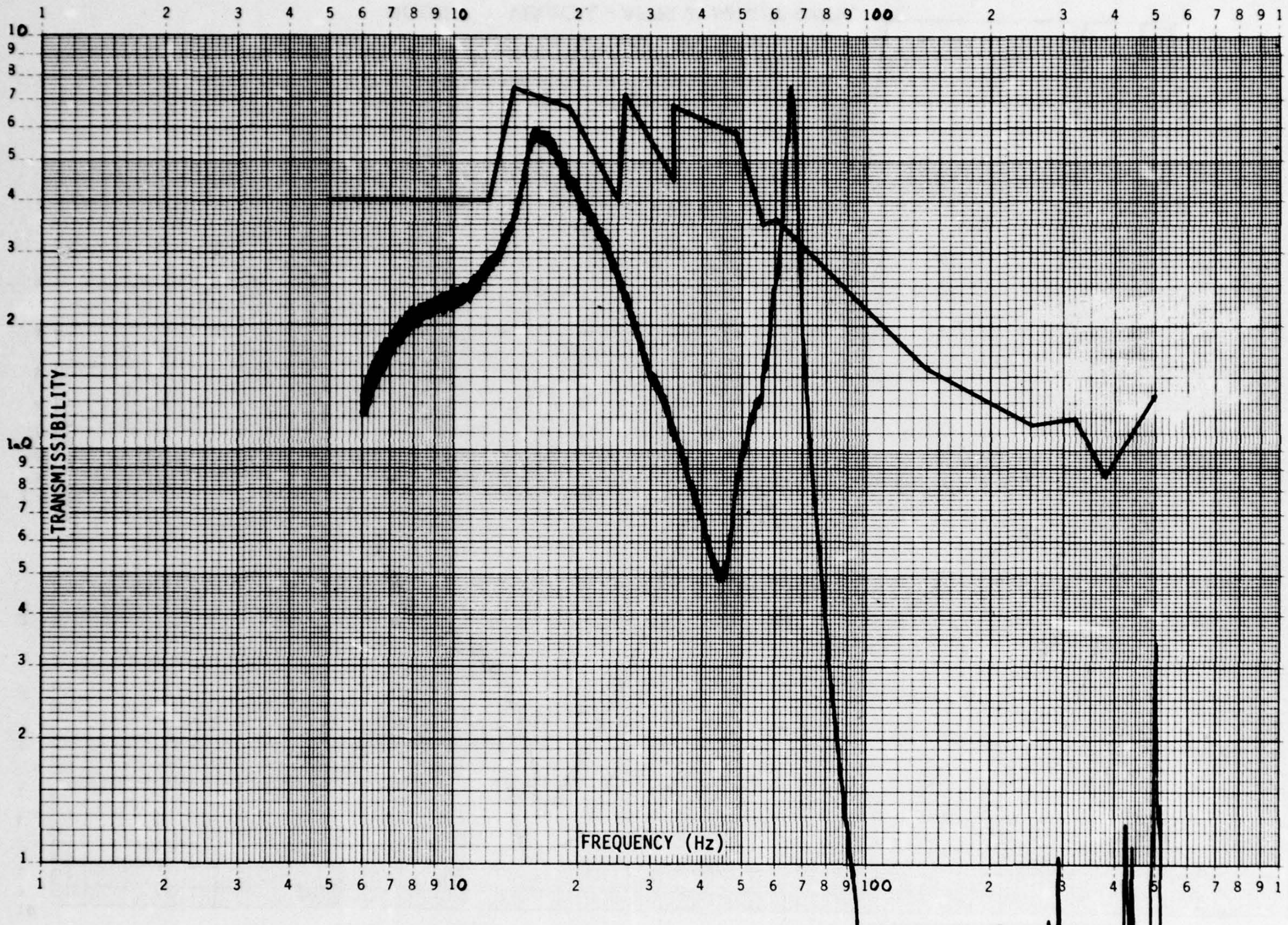


FIGURE 8 VERTICAL - RESONANCE SEARCH

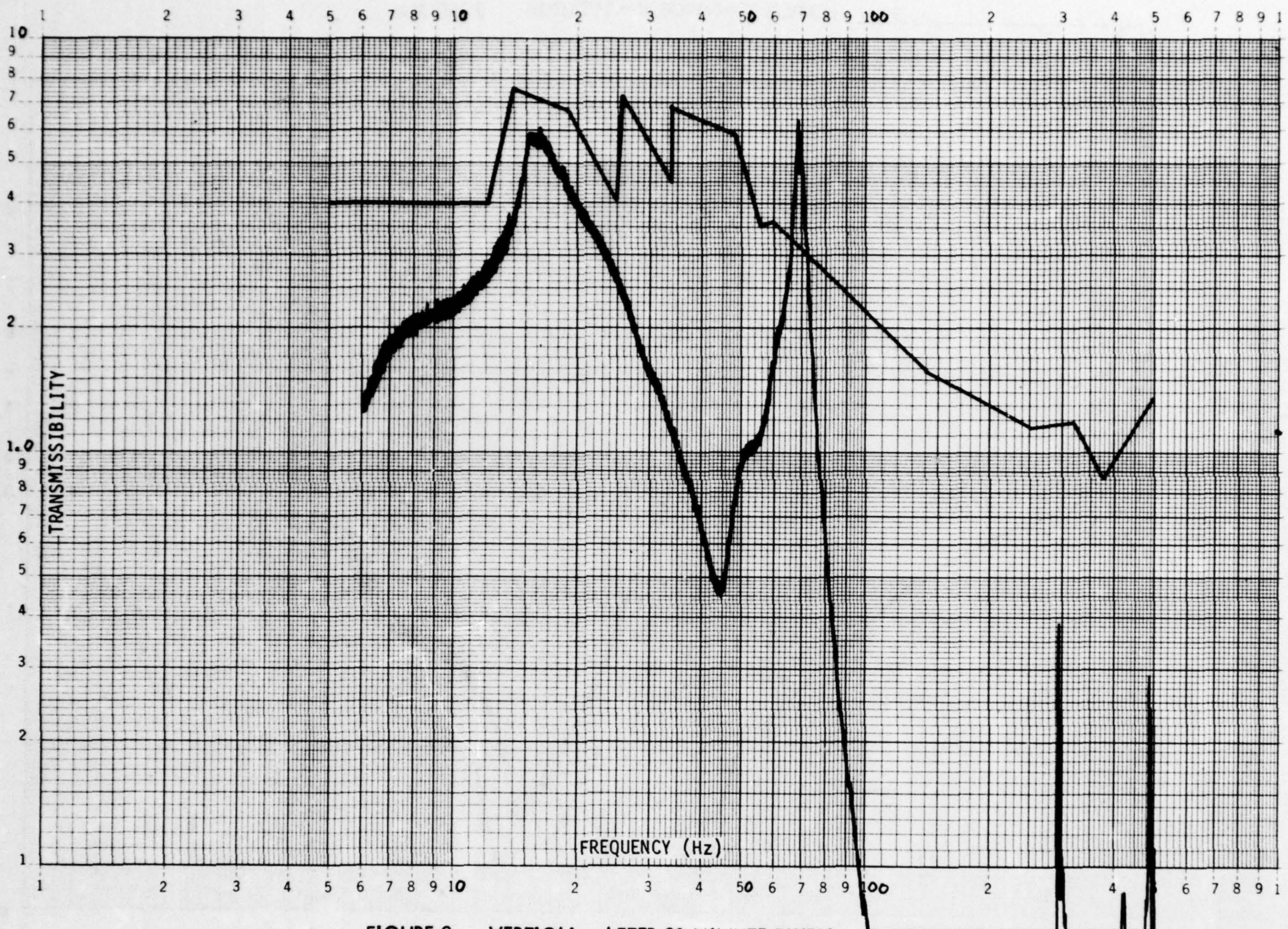
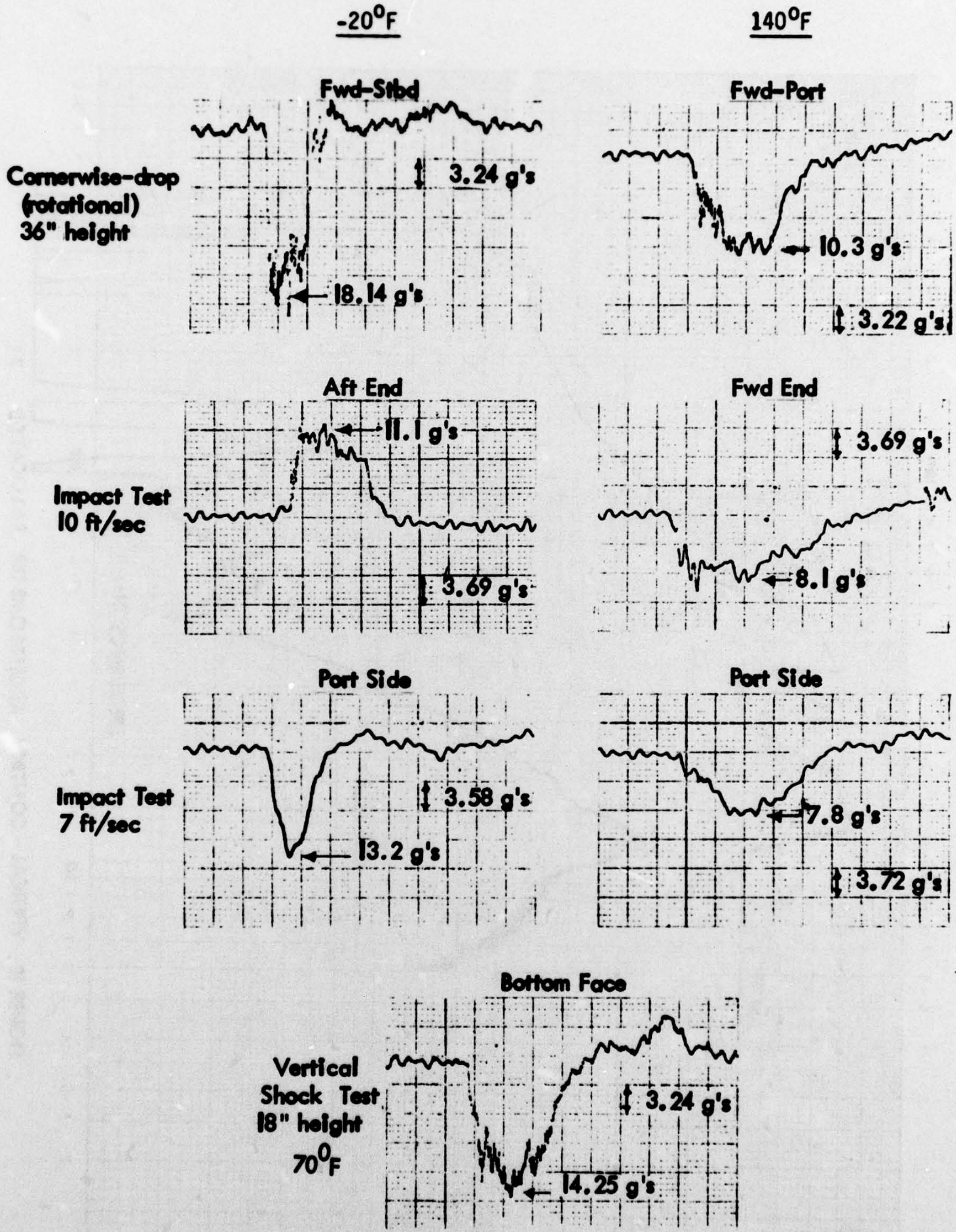


FIGURE 9 VERTICAL - AFTER 30 MINUTE DWELL

FIGURE 10 VERTICAL - CONTROL ACCELEROMETER RELOCATED



Note: Horizontal scale = 2.5 ms/mm

FIGURE II

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FIGURE 12
CONTAINER MK 618 MOD 0
36 INCH ROTATIONAL CORNERWISE DROP AT -20F

SHOCK SPECTRUM
SPECIFICATION = ◆
RESPONSE = +

FREQ HZ	SPEC G	RESP G
2.	6.5	3.5
4.	12.9	7.0
6.	19.1	10.3
8.	25.0	13.6
10.	30.5	16.7
14.	40.0	22.2
18.	47.0	26.5
22.	51.2	29.0
26.	52.6	30.0
30.	52.1	30.3
34.	48.5	30.4
38.	44.2	30.5
42.	40.0	30.8
46.	37.3	30.6
50.	36.6	30.5
60.	41.9	30.3
70.	45.7	29.8
80.	42.0	29.2
90.	39.0	28.7
100.	41.9	27.5
110.	44.4	27.1
120.	42.0	26.0
130.	39.8	25.2
140.	41.9	24.9
150.	43.8	24.1